



Measuring the Value of One-to-One Computing: A Case Study Perspective

By Leslie A. Wilson and Eric L. Peterson with contributions from Tammy Fry, Rich Kaestner and Andrew Zucker

In districts and states across this country, one-to-one laptop programs are “coming of age.” What have these early implementations taught us about the costs and benefits of 24/7 computing in schools?

Michigan's Freedom to Learn (FTL) initiative is one of a growing number of programs, nationally, designed to provide students with round-the-clock access to personal computers. Other states, including Maine, Massachusetts, New Hampshire, New Mexico, Texas and Vermont have statewide one-to-one programs underway. A growing number of individual schools and districts – from Henrico, Virginia, to Fullerton, California – have invested in their own 24/7 laptop programs. And interest continues to grow.

What are such ambitious pilot programs teaching us about the costs and benefits of one-to-one computing? In the pages that follow, we will take a closer look at what is being learned in Michigan and discuss some of the tools and approaches that schools, districts and states everywhere can apply to determine the value of their one-to-one programs.

Freedom to Learn Overview

The Freedom to Learn one-to-one program engages approximately 22,000 Michigan students, 1300 teachers, and 500 administrators and technology personnel. State and federally funded, the FTL complete package includes technology, curriculum standards, formative and summative assessment components, learning management, plus comprehensive and ongoing professional development. There is significant early evidence that FTL is enhancing achievement and education transformation.

Incorporating lessons from a 2001-2002 pilot involving seven demonstration sites, the FTL program expanded in 2003 with a focus on middle school students. The Michigan Department of Education and legislature provide guidelines for the operation of FTL. Primarily served are sixth grade middle school students from districts identified as ‘high need’ (low-income) and ‘high priority’ (not meeting Adequate Yearly Progress) with limited technology readiness.

The single-solution partner is Hewlett Packard (HP). Using its bulk purchasing power, the state provided, at \$1,040 per student, an education technology package that would normally retail for over \$2,750. The integrated solution from HP provides:

- Wireless laptop computers
- Online assessments
- Data center
- Learning management system
- Educational software
- Digital curriculum
- Professional development
- Help desk (available 24/7)
- Internet filter
- The highest available wireless security.

Learning from the Evaluations

By Dr. Andrew Zucker

In order for planners and policymakers to understand the costs and benefits of one-to-one implementations, it is essential to invest in well-designed research from the beginning of any program. Although relatively few one-to-one initiatives have been in place long enough to lead to extensive documentation, a gradually growing body of research indicates that there are clear benefits to one-to-one computing. (See "Resources for Learning More" to locate sources for research reports and evaluations.) Findings include:

Support from Participants

In two of the largest one-to-one computing programs in the country – the state of Maine, where all of the middle school students and teachers are given a laptop to use during the academic year, and Henrico County, Virginia, where more than 20,000 students in grades 6-12 use computers on loan from the district – studies show that teachers are strongly in favor of the programs, as are school administrators, parents, and the students themselves. This has been documented in multiple surveys and studies by a number of different organizations. These studies, and others that are underway at different one-to-one sites, from New Hampshire to California, suggest that students in the one-to-one programs demonstrate greater independence and are more self-directed in their learning, are more engaged in school, and show improvement in skills such as writing. Special education teachers are particularly enthusiastic because ongoing access to computers allows for individualized instruction, immediate feedback, repeated

practice, and accommodations for students with a variety of disabilities.

Test Scores

A recent review of research for Apple Computer found that there are very few rigorous studies of student achievement at one-to-one sites. As a result, evidence of improvements in students' test scores is still limited. However, preliminary results from studies such as the FTL evaluations reported elsewhere in this article show improvements in areas including writing and language arts. In addition, many earlier studies, and meta-analyses of studies, have documented the benefits of using computers in the classroom. And more information is on its way from the U.S. Department of Education, which currently is sponsoring a large, randomized experimental study of discrete educational software products in order to answer questions about benefits that computers may offer.

Equity and Opportunity

Policymakers are interested in one-to-one computing not only as a way to raise test scores, but also for other reasons, including the opportunity to increase students' equity of access to technology and information. As a result of one-to-one computing initiatives, many thousands of students who once had limited access to these resources are now on an equal footing with their more advantaged classmates. More program evaluations are needed to document and quantify these benefits. Similarly, with policymakers interested in one-to-one computing as a way to increase the economic competitiveness of their state

or district, it is hoped that evaluators will examine such variables as employers' changing perceptions of students' employability as a result of one-to-one programs.

School-Home Communication

Improved school-home connections constitute another important benefit of one-to-one computing programs. In Henrico County, for example, many community members are enthusiastic about the use of a Web portal from K12 Planet that provides administrators, teachers, parents, and students 24-hour access to information such as students' homework assignments and grades.

New Uses

We should also realize that many of the potential benefits of one-to-one computing are barely visible now, let alone well documented by high-quality research. Suppose, for example, that resources stored on a disk or a USB drive replaced print textbooks entirely. Students could mark up and interact with electronic texts without damaging them, have ongoing access to multimedia instruction in multiple languages, and be spared the need to lug heavy, bulky backpacks to school each day. Schools might save on the cost of textbooks, as well as reference materials such as encyclopedias and dictionaries. Some schools and companies are beginning to experiment along these lines – as well as exploring other new uses and benefits for the laptops to which their students and teachers have 24/7 access. As they do so, well-designed research has the potential to inform future decisions.

In the second year of implementation, ninety-five school districts and nearly 200 schools, geographically spread throughout Michigan's upper and lower peninsulas, make up the program. Each site is considered an innovative laboratory where curriculum and technology standards intertwine to create rigorous, personalized learning experiences. Just-in-time assessments provide immediate feedback to teachers and students. This allows for individualized and differentiated instructional and evaluation design.

Through software such as Microsoft's ClassServer and Scantron's Assessment Connection, FTL gives teachers the tools to assess, design and tailor instruction for each learner. A learning environment is generated where every child can have an Individualized Educational Plan, allowing learning to occur anytime, anywhere. Students are motivated to learn and produce through pathways within their natural habitat – a technology medium. Classrooms are student centered and breed teams of cooperative learners who engage in research, development and analysis as everyday tasks.

.....FTL Snapshot #1: Bendle Middle School.....

Some of the most powerful and positive results have been found in the percentage of students who have demonstrated proficiency on the Michigan Education Assessment Program (MEAP) tests for Reading and Math.

| MEAP Proficiency Scores | 2003-04 | 2004-05 |
|-------------------------|---------|---------|
| 7th grade Reading | 29% | 41% |
| 8th grade Math | 31% | 63% |

Grade Equivalent (GE) reading scores have also improved each year for 7th and 8th graders at the school. Seventh graders showed a .7 increase; eighth graders a 1.2 increase.

| Star Reading Scores | Fall 2002-03 | Fall 2003-04 | Fall 2004-05 |
|---------------------|--------------|--------------|--------------|
| 7th grade | | GE 6.3 | GE 7.0 |
| 8th grade | GE 5.2 | GE 5.6 | GE 6.8 |

This year's 9th graders have been in the FTL program since 7th grade. They have shown remarkable improvements in grade point averages, as indicated below:

Students with < 2.0 grade point average (GPA)

| GPA below 2.0 | 2003-04 | 2004-5 |
|--------------------|---------|--------|
| 9th grade students | 42% | 25.3% |

In addition, Bendle has observed the following positive results:

- Fewer students with final grades of D's or E's (from 29% in 2002-03 to 2% in 2003-04)
- Increased Summer School Enrollment (from 27 students in 2003 to 141 students in 2004)
- Level of suspensions down 5% from 2002-03 levels
- Absences down significantly (20% fewer students with 20 or more absences in 2003-04 than in 2002-03).

Evidence of Success

Is there real value from the FTL investment? Are there tangible results for each targeted area? FTL participants, the leadership team and the University of Memphis's Center for Research in Educational Policy (CREP) have partnered to find out. What follows are Freedom to Learn goals and evaluation results to date.

Goal 1 – Enhance student learning and achievement with an emphasis on developing the knowledge and skills requisite to the establishment of a 21st century Michigan workforce.

Current findings: Student and teacher surveys show the belief that students are gaining needed technology skills. Observations demonstrate that FTL students have reasonable computer literacy skills and can effectively engage meaningful technology learning activities.

Goal 2 – Provide greater access to equal educational opportunities, statewide, through ubiquitous access to technology.

Current findings: Tremendous strides have been made in giving students greater access to equal educational opportunities. Data from over 4000 FTL middle school students shows that the laptop program has increased their interest in learning, research skills, and future job opportunities.

Teachers report that using technology for learning has increased their student-focused practice and their students' motivation, achievement and technology skills.

Classroom observations showed that FTL lessons were significantly more effective at engaging students in learning than average teaching approaches represented in national norms.

Michigan Department of Education audits showed that districts had achieved significant program implementation, demonstrating that FTL's administration has a strong structural foundation.

FTL Snapshot #2: Kaleva Norman Dickson School District

Kaleva Norman Dickson School (KND) District is a consortium of five rural, low-income, school districts: Baldwin, Bear Lake, Clare, Kaleva Norman Dickson, and Mason County Eastern. The consortium covers 1,050 square miles and six counties and serves 1,180 middle school students.

Since the beginning of their participation in the FTL program, KND schools have shown improvements in MEAP scores. For example, at Bear Lake Schools, which have participated in the FTL program since 2003, significant gains were made in writing

MEAP scores – with scores more than doubling:

- In 2002, as 5th graders, students scored 33.3% proficient on the Writing MEAP.
- In 2004, as 7th graders they scored 76% proficient on the Writing MEAP.

In 2004, none of the students received the lowest score (a 1) on the writing portions of the test. This in itself is a large accomplishment. All students received 2's and higher. They scored 76% on the English Language Arts MEAP as well.

Reading scores remained relatively steady. In 2004 73% scored proficient on the Reading MEAP – representing a small drop from 78.6% in 2002. Given the small test group size and the fact that 41 students were tested in 2004, as opposed to 39 in 2002, the disappointing results could have been caused by low scores on the part of one or two students. Clearly, however, the FTL program has had a much more positive impact on writing than on reading scores.

“These data present triangulated support that the 2004-05 FTL program did provide greater access to equal educational opportunities statewide through ubiquitous access to technology.” (CREP, 2005)

Goal 3 – Foster effective use of the wireless technology/ instructional integration through systematic professional development for teachers, administrators and technology staff.

Current Findings: Professional learning has been extensive and differentiated to meet participants' needs and levels of knowledge and expertise. Over 1300 teachers and administrators participated in statewide development sessions.

CREP researchers concluded that FTL classroom teachers implemented lessons that were significantly more meaningful to their students than those implemented in classrooms represented by CREP's national norms.

FTL teachers' confidence to effectively integrate laptops with instruction and their belief that instruction and student learning are improved when students engage in 1-to-1 computing is significantly higher than those of other teachers, based on national norms.

Goal 4: Empower parents and caregivers with the tools to become more involved in their child's education.

Current findings: FTL students and teachers have gained a great deal of expertise with the laptop learning environment. Individual schools orchestrated parent/caregiver orientations and communications. Statewide, upcoming years will provide greater focus on parent/caregiver outreach.

Concurrent with the overarching program evaluation, many FTL teachers and administrators have organized and implemented their own research techniques. The “snapshots” on this page offer a closer look at specific results in two FTL districts.

As a whole, participants and observers have found the following elements to be crucial to the success of the program:

- **An all-inclusive solution:** The FTL program addresses hardware and software solutions, professional development, 24-hour support, and more.
- **A broad team approach:** Statewide stakeholders and groups such as the Michigan Department of Education are intimately involved in the development, decision-making and implementation of program essentials.
- **Extensive professional development:** Insiders and outsiders report that the 360 degree differentiated professional development is a major strength of the FTL program. A continuum of ongoing professional development is provided, statewide, stemming from a coach/mentor model. Supercoaches and lead teachers instruct and model necessary skills, “just in time,” as teachers around the state are ready for each experience.
- **TCO analysis:** A key element of the FTL professional development program involves working with each district to aid their decision making and understanding of how to address technology funding and resource allocation systemically. Total Cost of Ownership (TCO) analyses are part of FTL's professional development opportunities.

.....Challenges and Costs to Anticipate.....

By Tammy Fry

If your school, district or state is embarking upon a laptop initiative, it is crucial that you go into the experience with open eyes about the challenges as well as the promise of one-to-one computing. Some issues to consider:

Focusing on TCO

As is emphasized elsewhere in this article, budgeting for one-to-one initiatives involves much more than the one-time cost of buying laptops. Analyzing TCO and planning for such recurring or ongoing expenses as battery replacements, upgrades, warranty and deductible costs, software, and support are essential. Some districts have found themselves unable to continue laptop pilots after initial grant funding ran out because they were not able to budget successfully for the ongoing costs, including replacing the laptops when they broke down or became obsolete. One option worth considering is the use of leasing as a way to spread out costs and anticipate upgrade needs.

Training and Communication

One of the most significant costs that must be considered is professional development. If the technology is to be put into the hands of students for 24-hour use, the students, teachers and family members must be trained on uses and applications. There

are many one-to-one success stories today but there also stories of failed initiatives in which community or teacher buy-in was insufficient and the program was dropped. For one-to-one programs to work, teachers and other stakeholders must be prepped, educated and pro-active.

Determining Who Foots the Bill

With shrinking budgets, a number of schools -- both private and public -- have chosen to share the cost of their one-to-one programs with families, who purchase the laptops for home use. This is clearly not an option in low-income communities, however, and raises equity issues (or requires the district to help out extensively) in communities that are socioeconomically diverse.

Ensuring Access

Placing laptops in the hands of students is of little use unless there are connectivity options that follow them from classroom to home. Insuring that students have Internet access from home can be a big task that falls to districts when they implement 24/7 computing. One-to-one programs also are likely to require wireless capabilities within the school campus to allow the technology to travel with students from class to class.

Building the Infrastructure

Not only do school-wide wireless networks need to be planned, designed and built, but servers, backbone networks and broadband internet capacity need to be evaluated and upgraded to support the one-to-one program. These technology purchases and implementations are not always easy to estimate early on in the planning process, but funding should be made available to deal with them.

Tracking Results

As Andrew Zucker points out in the sidebar on page 2, it is essential for evaluation to be built into any program as ambitious as a one-to-one technology implementation. Doing this well and communicating effectively with constituents in order to build realistic expectations and share results as they become available are crucial to the success of a laptop program.

Note: A good reference for exploring such issues further is *Lessons Learned About Providing Laptops for All Students*, published by NEIRTEC (see "Resources for Learning More" on page 7), which offers lessons under five headings: hardware and software; planning; training and professional development; managing change; and, monitoring and evaluation.

Districts are encouraged to understand and plan their return on investment strategies with regard to technology.

- **A focus on research:** Research and best practice provide a foundation for the technology integration model that Michigan adopted. Details can be found at www.ftlwireless.org.

Looking at the Total Cost of Ownership

What is the TCO for the Freedom to Learn investment for each school and district? Several FTL districts, an FTL program director and an organizational consultant have dug deeply into this question over the past two years. Using the CoSN/Gartner TCO tool (www.classroomtco.org), the consultant's focus is to assist the districts in the computation of Total

Cost of Ownership for the administrative and instructional deployment of technology and to help them determine effective sustainability options beyond the FTL grants. The findings will guide schools to a systems approach for tackling matters related to organizational technology integration.

Currently, this analysis has been completed for three districts of the eight identified for TCO studies. What is clear is that each of the three districts, in its own way, has made serious progress at using technology to "cost avoid" in administrative areas. One district has aggressively provided shared facility laboratories and computers on wheels (COWS) and eliminated the use of individual classroom ink jet printers by migrating to strategically placed networked laser printers. Another district has enlisted parental/caregiver support in the purchase of devices in accordance with pre-defined standards. The final of

Measuring Value

By Rich Kaestner

Through its Taking TCO to the Classroom project, CoSN is investigating project costs and benefits to help schools measure Value of Investment (VOI) – in other words, to determine if a project is worth the cost.

Determining Cost

In order to have a sustainable one-to-one project, the costs need to be calculated over the life of the project. Initial purchases, training and implementation costs should be amortized or annualized over the life of the cost element, and ongoing costs added in. For example, some initial amortized costs would include laptops over four years, necessary upgrades to buildings over fifteen years, annual teacher training, and servers and network switches over five years.

Unbudgeted but real costs that should be considered are indirect labor and risk. Indirect labor is the “hidden” cost of time spent by users in training and dealing with system related issues. These costs are typically as large as or larger than the direct costs mentioned above. Risk is the probability of success for the project, measured from 0% to 100%. Risk is a rather subjective factor and is best arrived at via consensus.

Total Cost could be calculated as:

$$\frac{\text{annualized direct costs} + \text{indirect costs}}{\text{probability of success}}$$

where probability of success is a fraction from 0 to 1.

The CoSN-Gartner TCO tool is available to help schools determine current direct and indirect costs for technology. This tool can be used to provide valuable input to the one-to-one project cost estimates. Also available from CoSN is a spreadsheet designed to help users capture project costs.

Once projected costs have been calculated, any savings, special funding sources (grants, E-rate, etc.) and productivity enhancements (teacher time savings, for example) should be applied against the Total Cost, so that:

$$\text{Net Cost} = \text{Total Cost} - (\$ \text{ savings} + \text{value of productivity} + \text{funding})$$

The various costs, while calculated for the entire project, may also be expressed in per-student or per-computer terms for better understanding by constituents.

Measuring Benefits

Although there may be financial savings associated with one-to-one initiatives (for example, by making low-cost reference materials available or freeing up space formerly taken by a computer lab), few classroom technology projects have cost cutting as their primary goal. Instead, the benefits being sought generally relate to student learning, equity of access, or

21st century skills. How does one measure such benefits?

After identifying any anticipated dollar savings, qualitative benefits such as those mentioned above need to be aligned with a prioritized list of goals. These qualitative benefits, with anticipated results, should be stated in measurable terms as completely as possible. For example, improved student achievement can be defined in terms of specific goals such as a five point improvement in standardized test scores or an attendance increase from 91% to 94%.

Once these measurable goals have been identified, they need to be aligned with district, state and federal goals in order to determine the relative importance of each goal. This benefit information can be analyzed using a chart such as the one shown below.

Value of Investment

Attaching a dollar value to the Total Score of qualitative benefits is far from easy but it is a helpful way of assessing projects that are competing for the same funding. The overall VOI can be calculated as: (Total \$ Benefit + \$ value of Total Score) / Total Cost multiplied by 100%. A VOI greater than 100% has a positive value, and for competing projects, the project with the highest VOI has the best projected return on dollars spent.

| Mission/Goal Component | Importance 1 to 10 | Fit + 0 - | Effect 1 to 10 | \$ Benefit or Score |
|--|-----------------------|--------------|-------------------|------------------------|
| \$ Cost Savings | | | | |
| Increasing test scores in grades ... by ... points | | | | |
| Reduce absentee rate to ... | | | | |
| Bridge digital divide by ... | | | | |
| Develop the following skills crucial to trained work force: ... | | | | |
| Decrease Drop-out rate by ... % | | | | |
| more ... | | | | |
| Total Score | | | | |

KEY TO CHART:

Mission/Goal Component: List of all district/state/federal goals that may be impacted (positively or negatively) by the one-to-one project.

Importance: Relative importance of this goal to the school/district

Fit: How the one-to-one project fits with this goal

Effect: The relative effect the one-to-one project has on achieving this goal

\$ Benefit or Score: Anticipated \$ cost savings, \$ value of productivity gains, plus any means of converting qualitative measures into dollars. For qualitative benefits, **Score** = goal Importance x Effect.

Resources For Learning More.....

The following sites offer research reports, evaluations and links to existing one-to-one programs for K-12 education.

Apple's One-to-One Learning Site

www.apple.com/education/k12/onetoone/

The Center for Applied Research in Education Technology (CARET)

caret.iste.org

CoSN's Taking TCO to the Classroom web site

www.classroomtco.org

Florida's Laptops for Learning Task Force Report

etc.usf.edu/L4L/index.html

HP's One-to-One Computing for K-12 Education

h10038.www1.hp.com/k12/computing/index.asp

Gateway's 1:1 Success Stories

www.gateway.com/work/ed/k12/success.shtml

The Learning with Laptops (independent schools) web site

www.learningwithlaptops.com

K-12 Computing Blueprint from Intel/ Center for Digital Education

www.k12blueprint.com

Microsoft's Anytime Anywhere Learning Program

www.microsoft.com/Education/AALSupport.msp

MIT Media Lab's \$100 Laptop Initiative

laptop.media.mit.edu

National Study of the Effectiveness of Educational Technology Interventions (EETI)

edtech.mathematica-mpr.com

NEIR-TEC's Lessons Learned about Providing Laptops for All Students

www.neirtec.org/laptop

Project Inkwell

www.projectinkwell.com

Rockman et al's Learning with Laptops research

www.rockman.com/projects/topics/learningLaptops.php

The Ubiquitous Computing Evaluation Consortium

ubiqcomputing.org

In Michigan, the districts that have completed TCO analyses are rapidly recognizing the need to update, and in many cases, revamp their technology migration plans on an annual basis. They also recognize the need to continuously provide professional learning for staff, who are generally not digital natives, in order to tap into the cost saving and instructional delivery leveraging attributes of the technology.

Another area that has emerged as a consideration is the awareness that desktop and laptop device costs are rapidly declining. It is becoming clear that as technology commodity prices continue to decrease, parents and caregivers are increasingly likely to provide their children with mobile devices, putting districts in the role of providing secure, high-speed network and Internet access, 24/7, for computers that they do not control.

Overall, the three Michigan districts that have participated in the TCO analysis have realized that computer technology is here to stay. As student access to mobile computing devices becomes ever more commonplace, it is essential for schools to have faculty who are able to harness the power of such technologies to support learning. The FTL participants are aggressively exploring, in partnership with their communities, innovative ways to provide 24-hour technology and information access.

James Bosco, a retired Western Michigan University professor, has compared the deployment of individual student technology in the 21st century to the provision of individual student textbooks at the end of the 19th and beginning of the 20th century. Giving each student his or own textbook was once seen as a radical and costly venture. However, it eventually became clear that providing round-the-clock access to information gave students a portal to a world beyond their own. Similarly, one-to-one student deployment of technology devices today can be seen as offering a portal to a world in which each individual has ready access to global knowledge and understanding.

the three districts compressed acquisition costs by purchasing current but refurbished student devices, servers, and printers.

It has also become clear that staffing, deployment, and utilization benchmarks are moving targets. As the deploying organization's staff and students are becoming more device and software competent, the level of individual computer support needs has declined and software support needs have become more sophisticated. Technology-deploying districts are moderating some of their support costs by enlisting the services of highly capable high school and college students as interns.

This publication is one of six monographs that make up the 2006 CoSN Compendium, a collection of resources for members of the Consortium for School Networking (www.cosn.org), a national nonprofit organization that promotes the use of information technologies in K-12 education to improve learning. Please note that mentions of companies or products in this article do not represent endorsements. CoSN does not endorse products or services and specific references are provided only as examples to help readers understand developments and trends in the world of education technology.

Lead Authors:

- Leslie A. Wilson, director of professional and curriculum development, Freedom to Learn program.
- Eric L. Peterson, president, Peterson Public Sector Consulting, LLC

Additional Contributors:

- Tammy Fry, Technology Integration Specialist, Blue Valley Northwest High School, KS
- Rich Kaestner, Project Director, CoSN's Taking TCO the Classroom project
- Andrew Zucker, researcher, author and former co-director of the Ubiquitous Computing Consortium

Sponsors of CoSN's TCO Project

- Apple
- Dell
- Gateway
- HP
- Intel

Editing and Production:

Measuring the Value of One-to-One Computing was edited by Judy Salpeter and produced by CoSN with art direction by Chris Leonard.

CoSN Would Like to Thank the Following Media Sponsors for their Support:

C. Blohm & Associates, Inc.

CCI Crosby Publishing/Threshold magazine

CDW-G/EdTech Magazine

Center for Digital Education/Converge magazine

Distance-Educator.com

Education Week

eSchool News

Info-Tech Research Group

Marketing Projects, Inc./The Big Deal Book

MDR

Multimedia & Internet @ Schools

Scholastic Administr@tor

Technology & Learning

T.H.E. Journal

vivED

The Winter Group



Consortium for School Networking (CoSN)

1710 Rhode Island Avenue NW, Suite 900, Washington, DC 20036-3007

Phone: 202.861.2676 • Fax: 202.861.0888 • E-mail: info@cosn.org • Web: www.cosn.org